

## Acid-Base Equilibrium: Weak Acids and Bases

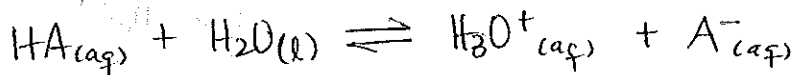
1. A 0.020 M solution of niacin has a pH of 3.26. Calculate the percent ionization.

$$[\text{H}_3\text{O}^+] = 10^{-3.26} = 5.5 \times 10^{-4} \text{ M}$$

$$\% \text{ ionization} = \frac{[\text{H}^+]_{\text{equil.}}}{[\text{HA}]_{\text{ini}}} \times 100$$

$$\frac{5.5 \times 10^{-4} \text{ M}}{0.020 \text{ M}} \times 100 = 2.7\%$$

2. A 0.100 M weak acid (HA) solution has a pH of 4.25. Find  $K_a$  for the acid.

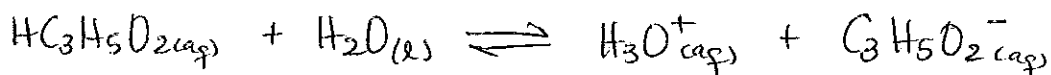


$$[\text{H}_3\text{O}^+] = 10^{-4.25} = 5.6 \times 10^{-5} \text{ M}$$

	[HA]	[H <sub>3</sub> O <sup>+</sup> ]	[A <sup>-</sup> ]
initial	0.100	0.00	0.00
change	-5.6 × 10 <sup>-5</sup>	+5.6 × 10 <sup>-5</sup>	+5.6 × 10 <sup>-5</sup>
equil.	0.100 - 5.6 × 10 <sup>-5</sup>	5.6 × 10 <sup>-5</sup>	5.6 × 10 <sup>-5</sup>

$$K_a = \frac{[\text{H}_3\text{O}^+][\text{A}^-]}{[\text{HA}]} = \frac{(5.6 \times 10^{-5})(5.6 \times 10^{-5})}{(0.100 - 5.6 \times 10^{-5})} = \underline{\underline{3.1 \times 10^{-8}}}$$

3. Find the pH of a 0.100 M  $\text{HC}_3\text{H}_5\text{O}_2$  solution.  $K_a = 1.3 \times 10^{-5}$



	$[\text{HC}_3\text{H}_5\text{O}_2]$	$[\text{H}_3\text{O}^+]$	$[\text{C}_3\text{H}_5\text{O}_2^-]$
initial	0.100	0.00	0.00
change	-x	+x	+x
equil.	0.100-x	x	x

$$\frac{[\text{HC}_3\text{H}_5\text{O}_2]}{K_a} = \frac{0.100}{1.3 \times 10^{-5}} = 7.7 \times 10^3$$

> 400 Assume x is small

$$K_a = \frac{[\text{H}_3\text{O}^+][\text{C}_3\text{H}_5\text{O}_2^-]}{[\text{HC}_3\text{H}_5\text{O}_2]} = 1.3 \times 10^{-5}$$

$$\frac{(x)(x)}{0.100 - x} = 1.3 \times 10^{-5}$$

$$\frac{x^2}{0.100} = 1.3 \times 10^{-5}$$

$$x = \sqrt{(0.100)(1.3 \times 10^{-5})}$$

$$x = [\text{H}_3\text{O}^+] = 0.0011 \text{ M}$$

$$\text{pH} = -\log [\text{H}_3\text{O}^+] = -\log (0.0011)$$

$$\text{pH} = \underline{\underline{2.96}}$$

4. What is the pH of a 1.5 M  $(\text{CH}_3)_2\text{NH}$  solution?  $K_b = 5.9 \times 10^{-4}$



	$[(\text{CH}_3)_2\text{NH}]$	$[(\text{CH}_3)_2\text{NH}_2^+]$	$[\text{OH}^-]$
initial	1.5	0.00	0.00
change	-x	+x	+x
equil.	1.5-x	x	x

$$\frac{[(\text{CH}_3)_2\text{NH}]}{K_b} = \frac{1.5}{5.9 \times 10^{-4}} = 2.3 \times 10^3$$

> 400 Assume x is small

$$K_b = \frac{[(\text{CH}_3)_2\text{NH}_2^+][\text{OH}^-]}{[(\text{CH}_3)_2\text{NH}]} = 5.9 \times 10^{-4}$$

$$\frac{(x)(x)}{1.5 - x} = 5.9 \times 10^{-4}$$

$$\frac{x^2}{1.5} = 5.9 \times 10^{-4}$$

$$x = \sqrt{(1.5)(5.9 \times 10^{-4})}$$

$$x = [\text{OH}^-] = 3.0 \times 10^{-2} \text{ M}$$

$$\text{pOH} = -\log [\text{OH}^-] = -\log (3.0 \times 10^{-2}) = 1.52$$

$$\text{pH} = 14.00 - \text{pOH} = 14.00 - 1.52 = \underline{\underline{12.48}}$$